Supplemental Research Studies and Compilation of Reference Materials
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An Analytical Approach to Safety in the Use of Chemicals and Fingerprint Powder in Forensic Identification

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Studies and evaluations pertaining to developing, recovering, transporting, and examining latent-print evidence have indicated that practitioners may face potential health hazards while processing latent prints at a crime scene or in a laboratory setting. Several studies, technical memorandums, and reports state that exposures to latent-print developing methods may result in increased illnesses unless proper safety procedures are strictly adhered to and personal protective equipment (PPE) is used. It has also been reported that there is an increased prevalence of respiratory illness due to occupational exposure among workers in the forensic identification group. This group works with an array of fingerprint powders, chemicals, and superglue in developing latent prints both at crime scenes and in laboratories.

Latent-print processing with fingerprint powders is primarily used at crime scenes. Many crime scenes lack adequate ventilation and clean airflow. Some crime scenes are confined areas. The processor may be exposed to fingerprint powder and chemicals of respirable size floating in the air. PPE, including respiratory protection, is considered to be sufficient protection at crime scenes to protect the practitioners. Unfortunately, it has been determined that many practitioners who process crime scenes do not use PPE. [1] [3]

Confined or enclosed spaces, which may be encountered in the field, may require the use of self-contained breathing apparatus (SCBA) or air supplied by hose from a compressor (airline respirator). If the ventilation of the environment is sufficient to reduce the concentration of the chemical, or in cases of short-term exposure, an air-purification respirator may be used. Chemicals should never be used without wearing at least an air-purification respirator even when there is sufficient ventilation or short-term exposure.

Depending on the chemicals used, there can be environmental contamination with residual effects for an indeterminate length of time.

In some instances, there has been indiscriminate use of chemicals within crime scenes that increased the exposure of the workers to hazardous chemical substances. Entire interiors of buildings have been saturated with ninhydrin. In one such case, the spray was administered by means of a hand-operated spray-mist bottle and used one gallon of ninhydrin with a petroleum ether, propanol, and methanol carrier. The only

PPE utilized was a disposable dust mist mask. In other cases, mass infusion of entire interiors of homes with superglue fumes occurred. It is not uncommon that over-fuming with superglue occurs, especially in the interior of motor vehicles. There have been occasions where the polymerization of the glue resembled a coating of snow in the interior of the vehicle. Instances such as this may be attributed to a lack of proper training and knowledge.

Safety Concerns in Using Chemicals at a Crime Scene

Spraying and/or application of chemicals at a crime scene present several concerns for the safety of the investigator/processor and environmental issues.

The application of chemicals at the crime scene may be a prelude to chronic health problems and even in some instances, acute health problems.

Personal contamination can come from:

Inhalation: If you can smell a chemical, you are inhaling it. Minimize your exposure. Inadequate or non-existent local ventilation may require the use of respirators such as line-supplied clean air or SCBA. If ventilation is sufficient to reduce or negate environmental concentrations of chemicals, an air-purifying respirator may be used in lieu of airline supply or SCBA.

Ingestion: This may occur when the investigator eats, drinks, or smokes within a crime scene where chemicals have been introduced. It can also occur when a person who has been handling chemicals or powders without gloves and masks—or even items that were treated with chemicals or powders—eats or drinks without first thoroughly washing the hands and face.

Absorption: This may occur through the mucous membranes, eyes, and skin surface. Many solvents, especially those that are organic, dissolve the oils on the surface of the skin and make it more susceptible for absorbing chemicals or solvents.

Keep in mind that the longer the exposure, the more likely you are to be affected by the chemical and carrier. Some people are more affected than others. This is dependent on the physical condition of the person. There are concerns that medications might interact with solvent and chemical combinations used in the processing of latent prints.

Spray application

It has been suggested that small, electrically powered paint compressors may be used in the spraying of chemicals at a crime scene. This procedure presents additional hazards to the user as well as being unreliable in regards to delivering accurate pressures. The spray is at an above-normal pressure and may more readily penetrate the surface of the skin when applying chemicals compared to a manually operated spray pump or atomizer. Precautions in the form of PPE must be adhered to when painting with an air-pressure supplied paint spray gun.

PPE is designed to prevent skin penetrations from spray, splash, or spills and protect the eyes and respiratory system. PPE should also provide protection from liquids, vapors, and mists. Heat-related illnesses may occur when using PPE, especially in confined or enclosed crime scenes.

When using chemicals, eyewash and body-wash provisions must be available. These are not normally encountered or provided at a crime scene. There are, of course, portable systems that may be taken to a crime scene.

Solvents and carriers are usually toxic, flammable, or both. If the chemical and its additives are flammable, PPE made of non-static discharge materials is required for outerwear. Most vapor densities are heavier than air.

The various carriers and solvents have different flash points, some of which are low. These may be set off or ignited by a number of things, such as:

- Sparks
- Open flames
- Electrical spikes
- Static electricity
- Refrigerators
- Fans
- Electrical outlets
- Flashlights
- Cell phones/faulty batteries

Safety procedures recommend the use of a fume hood for most chemical-enhancement methods (application or preparation). This will reduce both the introduction of the chemical into the environment and the chance of an explosion.

Spraying is not recommended for ninhydrin and/or other chemicals or carriers. Dipping or painting are the preferable methods of application for developing latent prints. Spray techniques for chemicals are normally conducted in a laboratory for safety because the laboratory setting normally provides the necessary PPE (protective gloves, laboratory coats, eye protection), as well as engineering controls (ventilation hoods and climate control), adequate work space and lighting, and wash stations.

The manufacturer-supplied Material Safety Data Sheet (MSDS) may list potential hazards, but many of the ingredients of a chemical are not disclosed by the manufacturer due to the manufacturer's proprietary rights. Therefore the MSDS may not have sufficient information or warnings.

The solution or carrier may cause deterioration (defatting) of the protective hyrdolipid film of the skin's surface resulting in the permeation of the skin by the solution.

Liability Factors (Workman's Comp Issues)

Scenes that were part of the fruits of the crime differ from items introduced into the scene by investigatory procedures or methods. In many jurisdictions the department becomes civilly responsible for destructive application of processing techniques. Issues may arise as to the destruction of property or the cleaning of the scene, etc. In general, the use and application of many chemicals may require:

- Self-contained breathing apparatuses
- Chemical retardant PPE
- Anti-static PPE
- Full-face respirators
- Bunker suits
- Mixing volatile carriers/solvents with the chemical
- Spraying
- Immersion
- Washing and rinsing
- Heat application

- Well-ventilated areas
- Fume hood
- Cool storage areas
- Appropriate safety containers
- Proper labeling of materials
- Protracted processing time
- Supergluing surfaces prior to chemical application
- Wash stations

The many facets involved with the use of chemical processing at a crime scene may result in variable threat levels to the use and as well as the environment. Due to these many considerations and hazards, the use and application of chemicals at a crime scene should be avoided.

Other considerations

- The use and application of chemicals in field situations may be governed and prohibited by environmental protection agencies. Regulatory agencies can be local, state, or federal.
- Proper disposal requirements of chemical preparations must be adhered to. This is also regulated by local, state, and federal entities.
- Transportation of chemical preparations to scenes is hazardous and may be subject to Department of Transportation (DOT) regulations.
- Spills involving chemicals must be cleaned up in compliance with federal, state, and local regulations as applicable.
- Requirements and regulations may vary from agency to agency and failure to comply is usually enforceable and punishable. Environmental protection agencies generally do not accept ignorance as an excuse.

Chemical preparations should be made in a laboratory setting and within a fume hood while utilizing PPE. The mixing and use of chemicals appears to be more prevalent in the laboratory setting than in the field. This is normally done in a fume hood, which provides a local exhaust control. Local exhaust systems are not found at most crime scenes. Exposures are considered to be of a lesser degree in laboratory settings than in the field because it is expected that engineering control measures such as fume hoods are used which provide greater protection in conjunction with the appropriate PPE. Even so, secondary exposure may occur in laboratories.

At crime scenes, the processor may spend a protracted period of time processing items for latent-print evidence. This is considered to be a primary exposure to powders and, in some incidences, chemicals used in the development of latent print evidence. Secondary exposures may also occur.

What is a secondary exposure?

Secondary exposure is indirect contact with a contaminant. This comes from its presence in an environment because of inadequate ventilation or cleaning or inadvertent contact and transfer.

For example: Secondary exposure in the field may occur during the processing, collecting, packaging, and transportation of evidence. Airflow may distribute contaminates or particulates to other areas outside of the core area of crime-scene processing.

Contaminates may adhere to evidence packaging materials that come in contact with contaminated surfaces in the crime-scene processing area. They can then transfer to other surfaces the packaged evidence touches. Similarly, careless removal and disposal of PPE can cause inadvertent transfer of contaminants. If PPE is not used, the processor's clothing will transfer particulates and contaminants to other surfaces, including car seats.

Many crime-scene vehicles may cause secondary exposure due to the components of processing materials that may be found in the vehicle. These may be fingerprint powders of various types, alcohol, ninhydrin, cyanoacrylate, etc. The interiors of crime-scene vehicles are subject to extreme variances that may cause thermal decomposition (degradation) of products that are stored and carried in the vehicle.

It should be noted that fingerprint powders are designed to adhere to any surface. This also means it will adhere to exposed skin areas, clothing and/or protective lab coats or other PPE. This type of exposure to powder contaminants is considerably longer than the actual time of active dusting with the powder. This unwittingly increases exposure time to the powders(s).

Secondary exposure in the laboratory or examining facility may occur when evidence that has been treated is taken out of the processing room to the examiner's desk, especially when the item has been treated with chemicals and is not completely dry. Lab coats and other non-disposable protective garments are sometimes worn out of the processing area into office facilities. There is a strong potential for contaminating the office or common areas from protective garments that are not removed, properly disposed of, or stored prior to entering a common area.

Improper storage of chemically treated or processed evidence items may result in cross-contaminated environments. Evidence cabinets or storage facilities should be located in a room that is under negative pressure and that has a dedicated exhaust system. If an evidence-examining or -processing room is not a negative-pressure controlled environment, it is reasonable to presume that airborne particulates or other contaminates will transfer to other common areas. Processing-room air should not be recirculated within the building or mixed with the general dilution ventilation for the building. This can result in office-air contamination.

A risk of chemical exposure due to ingestion may occur if the proper air-handling controls are not in place. An even greater risk occurs when examiners handle chemically treated evidence at the same desks where they also eat and drink.

Individual use of and exposure to powders is dependent on the number of cases processed, the length of time exposed to the powder, the skill and technique of the investigator, and personal hygiene. Personal observation has indicated that some investigators use up to two pounds by volume of regular fingerprint powder in a year.

It has been suggested that if manpower and fiscal resources are available, it may be of benefit to have an industrial hygienist on staff. This should provide a more comprehensive evaluation and assessment of potential hazards, ensure safety procedures are adhered to, and ultimately reduce or eliminate hazards to which workers are exposed. [1]

Safety and Safety Programs

A safety program should provide guidance and training for all employees, field, and bench personnel in the laboratory. Training should be conducted more than once a

year. Training and education are ongoing processes and some subjects, like safety, need emphasis and repeating. This should be incorporated into management oversight responsibilities.

Chemical hygiene plans should be incorporated into the day-to-day activities of those actively involved in the development, recovery, transportation, and examination of latent fingerprint evidence. The plan should encompass continuity, training, and the compliance with workplace safety both in the field and in laboratory settings. Adequate stocks of safety equipment and supplies should be maintained and made available for use. The implementation of chemical hygiene and the use of all appropriate equipment should be actively supervised and enforced. This would reduce the individual's health risk as well as a department's liability exposure.

Above-normal incidents of time lost from work by those assigned to latent-print processing in the field or laboratory due to illness or reported work-related illness might be an indicator that there is a safety issue or hazardous-exposure problem. For instance: Consider a 20-person unit assigned to process for latent-print evidence. Over a period of time, eight of them contract similar health problems such as skin allergies, cancer, and/or respiratory problems. Forty percent of the work force is affected and this in itself may be indicative of a systemic problem. Add the similar nature of the heath problems and it's a virtual surety.

Considerations in general safety aspects pursuant to OSHA 29CFR 1910 132

• "Employers must conduct a hazard assessment to determine if hazards present necessitate the use of PPE."

• "Employers must certify in writing that the hazard assessment was conducted."

• "PPE selection must be made on the basis of hazard assessment and affected workers must be properly trained."

• "Defective or damaged PPE must not be used."

• "Established training requirements for employees using PPE must be established. This should include requirements for employees to demonstrate an understanding of the training."

• "Employer must certify in writing that training programs were provided and understood."

Fingerprint Powders

The Department of Health Care and Epidemiology, University of British Columbia, in conjunction with the Canadian Police Research Center, submitted a technical report TR-06-95, "Exposure and Health Status of Canadian Law Enforcement Personnel Associated with Identification Procedures". This report addresses the studies and results pertaining primarily to fingerprint powders.

Some purveyors or manufacturers of fingerprint powders do not readily share information about their powders beyond the bare minimum required by law. Many ingredients are not provided under the "exclusion of proprietary right information". Much effort was put into determining the ingredients used when manufacturing various fingerprint powders. The following list shows these ingredients that are used singly or in combination with each other. Many of these ingredients aren't listed on the respective MSDSs and therefore all health warnings, irritation, and respiratory

effects, etc. may not be listed in the MSDS, either. It is necessary to do specific research on the individual components to obtain truly accurate information.

Prior to 1967, mercury-based powders were commonly used. [2] They were recovered from the market. For example: Hydragyrum was comprised by weight of one part mercury and two parts chalk. [2] As recent as 1993, some base materials found in fingerprint powders consisted of 41% lead.

According to MSDS information, most fingerprint powders are considered to be a nuisance dust. There is a wide range of fingerprint-powder compositions on the market today; in general, they usually consist of an adhesive, a resinous polymer, and a color contrast.

Some of the components that are found in fingerprint powders include, but are not limited to, the following:

- Starch
- Charcoal
- Resin
- Silica Gel
- Silicon
- Iron Oxide
- Manganese Dioxide
- Fluorescein (1)
- Rhodamine B (2)
- Pulverized Quartz
- Manganese
- Stoddard Solvent
- Black Iron Oxide
- Titanium Oxide
- Acridine Orange
- Nile Blue
- Aluminum Flakes
- Kaolin
- Carbon Black
- Steric Acid
- Iron
- Pumice
- Calcium
- Zinc
- Magnesium
- Bronze Flakes
- Nichol
- Lycopodium
- Rocket Red AX Pigment
- Acridine Yellow
- Crystal Violet
- Lead

Powder formulations containing metallic components and meshed metals are considered to be toxic in general. [6]

"It has been determined that some powders may contain some microgram levels of polyaromatic hydrocarbons (PAHs)." [3]

"Some scanning electron microscope images revealed what appeared to be, small fragments of organic material that were of respirable size." [3]

Only a few powders were tested and it is not known how widespread this is among the powders.

Managerial oversight

Fingerprint powders should be qualitatively and quantitatively examined. Safety should be considered along with effectiveness in approving any powder for use and appropriate safety measures should be initiated and supported for each powder used.

Statements and information presented in the above article are in good faith and believed to be accurate. Regulatory requirements are subject to change and may differ from one venue to another.

Bibliography

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